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Combinatorial Auction for Grid Computing

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Abstract*— Grid computing, emerging as a new paradigm for next-generation computing, enables the sharing, selection, and aggregation of geographically distributed heterogeneous resources for solving large-scale problems in science, engineering, and commerce. The resources in the Grid are heterogeneous and geographically distributed. The paper demonstrates the capability of economic-based systems for wide-area parallel and distributed computing by using auction-oriented approach. In this paper combinatorial auction has been discussed. This auction model allows biders to bid on various attributes beyond the price .The overall utility of a deal for the buyer must consider a combination of the different attributes. This model has also been implemented. The auctioneer selects winners based on the price as well as on other attributes.

Index Terms*— Combinatorial Auction, Grid computing, Resource management, Economic models and Auction Models.

I. INTRODUCTION

As defined by Ian Foster and Carl Kesselman [6] "A computational grid is a hardware and software infrastructure that provides dependable, consistent, pervasive, and inexpensive access to high-end computational capabilities" Grids are a form of distributed computing whereby a "super virtual computer" is composed of many networked loosely coupled computers acting together to perform very large tasks. Grid computing is the federation of computer resources from multiple administrative domains to reach a common goal. The grid can be thought of as a distributive system with non-interactive workloads that involve a large number of files. What distinguishes grid computing from conventional high performance computing systems such as cluster computing is that grids tend to be more loosely coupled, heterogeneous, and geographically dispersed. Although a single grid can be dedicated to a particular application, commonly a grid is used for a variety of purposes. Grids are often constructed with general - purpose grid middleware software libraries[11]. Grid Resource Management means identifying application requirements, resource specification, matching resources to applications, allocating/scheduling and monitoring those resources and applications over time in order to run as effectively as possible. Grid size varies a considerable amount. Most of the related work in Grid computing dedicated to resource management and scheduling problems adopt a conventional style where a scheduling component decides which jobs are to be executed at which site based on certain cost functions (Legion [3], Condor [8], AppLeS [1],Netsolve [2], Punch [7]).

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Grids are a form of distributed computing whereby a "super virtual computer" is composed of many networked loosely coupled computers acting together to perform large tasks. For certain applications, "distributed" or "grid" computing, can be seen as a special type of parallel computing that relies on complete computers connected to a network by a conventional network interface.

Auctions basically use market forces to negotiate a clearing price for the service.[9] [10].The auction model supports one-to-many negotiation, between a service provider (seller) and many consumers (buyers), and reduces negotiation to a single value (i.e., price). The auctioneer sets the rules of auction, acceptable for the consumers and the providers.

Auctions can be classified into four types:
1.English Auction (first-price open cry)[5]
2.First-price sealed-bid auction
3.Dutch Auction[4]
4.Continuous Double Auction

Combinatorial Auction allows bidders to bid on various attributes beyond the price. The auctioneer selects winners based on the price as well as on those various attributes. Thus, the overall utility of a deal for the buyer must consider not only the price of the auctioning item, but also a combination of the different attributes. This is basically an auction model.This difference is a major change from the traditional basic auction mechanisms which negotiate only on price. Electronic procurement environments can be set as an applications. A buyer first has to define his preference for certain goods in terms of various attributes in a form of a utility. The buyer has to reveal her utility to suppliers. A supplier should bid based on this. The mechanism selects the supplier who produces the highest overall utility for the buyer (i.e., the bidder who best fulfills the buyer's preferences).

Auction model:

The auction model supports one-to-many negotiation, between a service provider (seller) and many consumers (buyers), and reduces negotiation to a single value (i.e. price). The auctioneer sets the rules of auction, acceptable for the consumers and the providers. Auctions basically use market forces to negotiate a clearing price for the service. The steps involved in the auction process are:

1. a GSP announces their services and invites bids;
2. brokers offer their bids (and they can see what other consumers offer if they like—depending on how open/closed);
3. step 2 goes on until no one is willing to bid a higher price or the auctioneer stops if the minimum price line is not met;
4. the GSP offers the service to the one who wins;
5. the consumer uses the resource.

Auctions can be classified into five types:

- English auction (first-price open cry);
- first-price sealed-bid auction;
- Vickrey (second-price sealed-bid) auction [18];

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• Dutch auction;
• double auction (continuous).

English auction (first-price open cry).
All bidders are free to increase their bids exceeding other offers. When none of the bidders are willing to raise the price anymore, the auction ends, and the
highest bidder wins the item at the price of his bid. In this model, the key issue is how GRBs decide how much to bid. Those not interested in bidding anymore can openly declare so (open-exit) without the possibility of re-entry. This information helps other bidders and gives them a chance to adjust their valuation.

First-price sealed-bid auction.
Each bidder submits one bid without knowing the others' bids.The highest bidder wins the item at the price of his bid. In this case a broker bid strategy is a function of the private value and the prior beliefs of other bidders' valuations. The best strategy is to bid less than the true valuation and one might still win the bid, but it all depends on what the others bid.

Vickrey (second-price sealed-bid) auction. Each bidder submits one bid without knowing the others' bids. The highest bidder wins the item at the price of the second highest bidder [18].

Dutch auction.
The auctioneer starts with a high bid/price and continuously lowers the price until one of the bidders takes the item at the current price. It is similar to a first-price sealed-bid auction because in both cases the bid matters only if it is the highest, and no relevant information is revealed during the auction process. From the broker's bidding strategic point of view, a Dutch auction is similar to an English auction (first-price sealed-bid auction). The key difference between them is that in an English auction the bids start with a low opening and increase progressively until demand falls, whereas in a Dutch auction the bids start with a high opening price and decrease progressively until demand rises to match supply. In terms of real time, the Dutch auction is much more efficient as the auctioneer can decrease the price at a strategic rate and the first higher bidder wins.

Double auction
This is one of the most common exchange institutions in the marketplace whose roots go back to ancient Egypt and Mesopotamia [15]. In fact, it is the primary economic model for trading of equities, commodities and derivatives in stock markets (e.g., NASDAQ). In the double auction model, buy orders (bids) and sell orders (asks) may be submitted at anytime during the trading period. If at any time there are open bids and asks that match or are compatible in terms of price and requirements (e.g., quantity of goods or shares), a trade is executed immediately. In this auction orders are ranked highest to lowest to generate demand and supply profiles.Researchers have developed software-based agentsmechanisms to automate the double auction for stock trading with or without human interaction [9].
The double auction model has high potential for Grid computing.
All the above auctions differ in terms of whether they are performed as open or closed auctions and the offer price for the highest bidder. In open auctions, bidding agents can know the bid value of other agents and will have an opportunity to offer competitive bids. In closed auctions, the participants' bids are not disclosed to others.

II. COMBINATORIAL AUCTION

Combinatorial Auction plays a very important role in our economy in the following way:
(i) Internet- based markets adopted this structure.
(ii) Used as an Industry procurement.
(iii) Many markets for services are organized in a form reminiscent of private multi-attribute auctions.

III. COMPARISON OF TRADITIONAL AND COMBINATORIAL AUCTIONS

Combinatorial Auctions differs from standard low price auctions in that :-
(a) The exact weighting scheme that is used to determine the winner is not announced.
(b) A buyer chooses a winner on the basis of several indicators instead of taking only a price quote into account.

IV. COMBINATORIAL AUCTIONS IMPLEMENTATION

Proposed Algorithm :
- This Auction allows bidders to bid on various attributes beyond the price.
- The overall utility of a deal for the buyer must consider a combination of the different attributes.
- The generic procedures for Proposed Auction 1 is :

1. A buyer first define her preference for certain goods in terms of various attributes as a utility function.
2. The buyer reveals her utility function to suppliers.
3. A supplier bids based on this utility function.
4. The mechanism selects the bidder who best fulfills the buyer's preferences.

Attributes	Buyer 1	Buyer 2	Buyer 3
Price Minimal acceptable value-100 Weightage-25	**110**	**111**	**210**
Employee Strength Minimal acceptable value-100 Weightage-25	**90**	**103**	**150**
Location Minimal acceptable value-5 Weightage-25	**7**	**7**	**34**

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Quality Minimal acceptable value-4 Weightage-25	**4**	**6**	**21**

V. RESULTS OF COMBINATORIAL AUCTIONS

The experiment considers a Proposed Auction Model. In this there are four attributes,eg- Price, Employee Strength , Location and Quality. For each attribute minimum acceptable value and weightage are given. The three buyers are buyer 1,buyer 2 and buyer 3.For each buyer bid for each attribute has been asked. The buyer 3 is the winner in the table shown below.

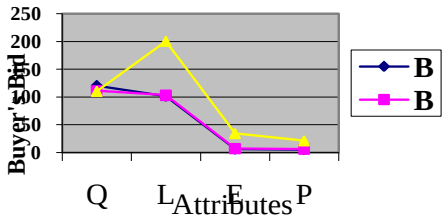
Combintorial Auction :

Table for Combinatorial Auction

Attributes	Buyer 1	Buyer 2	Buyer 3
Quality Minimal acceptable value-100 Weightage-25	**110**	**111**	**220**
Location Minimal acceptable value-100 Weightage-25	**90**	**103**	**150**
Employee Strength Minimal acceptable value-5 Weightage-25	**7**	**7**	**34**
Price Minimal acceptable value-4 Weightage-25	**4**	**6**	**21**

According to this table,graph has been plotted for this Auction.

Combinatorial Auctions



VI. CONCLUSION AND FUTURE WORK

Proposed Auction Model 1 allows bidders to bid on various attributes beyond the price. The auctioneer selects winners based on the price as well as on those various attributes. Thus, the overall utility of a deal for the buyer must consider not only the price of the auctioning item, but also a combination of the different attributes.

In the future, it is possible to develop agents that can automatically choose one out of a set of auction protocols according to the requirements of the Grid environment.

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